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MILTON AND GALILEO

BY ALLAN H. GILBERT

Galileo the astronomer is the only one of Milton's contemporaries who obtained a place in *Paradise Lost.* This discoverer of new truths about the material universe seemed to the poet the one among the men he knew whose name posterity would most unwillingly let die. Yet he had seen Galileo not as the triumphant herald of new discoveries, but as one of the martyrs of science. "I found and visited," he writes in the *Areopagitica,* "the famous Galileo grown old, a prisoner to the Inquisition, for thinking in astronomy otherwise than the Franciscan and Dominican licensers thought." This visit represents the poet's love for freedom of thought, which was itself enough to direct his attention to a man suffering under tyranny, especially ecclesiastical tyranny, for truth's sake. Yet his sympathy with Galileo was also the expression of his desire for scientific teaching truer than the decadent Aristotelianism which found a champion in the church that had silenced the great astronomer.

The chief evidence of Milton's early rebellion against the school of thought that condemned Galileo is found in his university orations, one of which is entitled *Contra Philosophiam Scholasticam.* He writes in the spirit of Bacon:

> Cui et hoc egregium afferet compendium, si quis norit et artes utiles, et utilia in artibus recte seligere. Quot sunt imprimis Grammaticorum et Rhetorum nugae aspernabiles! Audias in tradenda arte sua illos barbare loquentes, hos infantissimos. Quid Logica? Regina quidem illa artium si pro dignitate tractetur. At heu quanta est in ratione insania! Non hic homines, sed plane Acanthides carduis et spinis vescuntur. O dura Messorum ilia! Quid repetam illam, quam Metaphysicam vocant Peripatetici, non artem inquam plerumque, sed infames scopulos, sed Lernam quandam Sophismatum ad naufragium et pestem excogitatem? Haec illa quae supra memini togatae ignorantiae vulnera sunt. Haec eadem cucullorum scabies etiam ad naturalem philosophiam late permanavit; vexet mathematicos demonstrationum inanis gloriola; his omnibus quae nihil profutura sunt merito contemptis et amputatis, admirationi erit quot annos integros lucrabimur.[1]

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[1] *Prolusio* 8, p. 466 (*The Works of Milton,* Pickering edition, Boston, 1851, vol. 7).

By the example of Aristotle,[2] Milton endeavors to encourage his hearers to studies more profitable than quarrels about words. He strongly recommends the natural sciences, among them astronomy:

> Nec vos clam sit quid sibi velit aut Jupiter aut Natura, cum dirus atque ingens Cometa coelo saepe minitatur incendium, nec vos vel minutissimae lateant stellulae, quotquot inter polos utrosque sparsae sunt, et dispalatae: immo solem peregrinantem sequamini comites, et ipsum tempus ad calculos vocate, aeternique ejus itineris exigite rationem.[3]

In another list of delightful studies, astronomy (" omnem coeli syderumque morem ")[4] comes first. In this respect for Aristotle, the youthful Milton agrees with Galileo, who had a good word for the philosopher himself, though he did not approve of the methods of the Peripatetics. He thus condemns the disciples by the example of the master:

> Dico, che noi aviamo nel nostro secolo accidenti e osservazioni nuove e tali, ch'io non dubito punto, che se Arisottile fusse all'età nostra, muterebbe opinione; il che manifestamente si raccoglie dal suo stesso modo di filosofare; imperocchè, mentre egli scrive di stimare i Cieli inalterabili ec. perchè nissuna cosa nuova si è veduta generarvisi o dissolversi delle vecchie, viene implicitamente a lasciarsi intendere, che quando egli avesse veduto uno di tali accidenti, avrebbe stimato il contrario.[5]

But though Milton respected Aristotle, he was far from being a Peripatetic. In a university oration entitled *De Sphaerarum Concentu* he takes the side of Pythagoras against Aristotle. A difference on the music of the spheres does not now seem of scientific moment, yet in Milton's day Pythagoras was opposed to Aristotle as the upholder of the belief that the earth moves. Copernicus himself set out from the speculations of Pythagoras, and Galileo speaks of the " opinione Pittagorica della mobilità della Terra."[6] Consequently, if Milton was ready to prefer Pythagoras to Aristotle in one matter, we may suspect equal readiness in others.

Milton was interested in mathematics—a subject which devoted Aristotelians believed unnecessary, since they could depend on the words of their master.[7] Galileo, however, used mathematics freely, and looked forward to further developments in the subject. When Milton resided at Horton he was in the habit of repairing to London "for learning . . . the mathematics." [7a] This sets him among the Pythagoreans rather than among the Aristotelians.

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[2] *Prolusio* 3, p. 430. [3] *Ibid.*, p. 429. [4] *Prolusio* 8, p. 462.

[5] *Dialogo intorno ai due massimi sistemi del mondo tolemaico e copernicano*, p. 58 (Le Opere di Galileo Galilei, Firenze 1842, vol. 1). Cf. p. 146.

[6] *Dialogo*, p. 11.

Though natural science appeared to the young Milton so important that he urged its study on his fellow students, and though he was early inspired with the spirit of resistance to the scholastics, we do not know that in his youth he became familiar with the Copernican astronomy. From his early writings we would infer that he did not. Scarcely one of the poems written before his journey to Italy is without references to astronomy, yet these references are invariably Ptolemaic. In the poem entitled *De Idea Platonica Quemadmodum Aristotles Intellexit* he mentions the " ordines decemplicis " of the sky, and in *Comus* he wrote:

> We that are of purer fire
> Imitate the starry quire,
> Who in their nightly watchful spheres,
> Lead in swift round the months and years.[8]

The large number of astronomical passages in the earlier poems cannot be explained by literary convention; in youth the poet must have laid the foundation for the astronomical knowledge evident in his later writings.

But notwithstanding the evidence of his early poetry, Milton probably learned of the Copernican doctrines either during his college career or in the course of his private studies at Horton. In their general circulation, the new astronomical theories could not have failed to reach a man of his intellectual curiosity. And the writings of Galileo were, we are told, "largely read in England." [9] There are in the British Museum MS. translations of some of his works, including his *Dialogue on the Two Principal*

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[7] *Ibid.*, p. 16.

[7a] *The Earliest Life of Milton*, p. xxiv (in *Of Education*, etc. edited by Laura E. Lockwood, Boston, 1911). Milton himself writes: Rus urbe mutarem . . . gratia . . . aut novum quidpiam in mathematicis vel in musicis, quibus tum oblectabar, addiscendi (*Defensio Secunda*).

[8] Lines 111-14.

[9] J. J. Fahie, *Galileo, His Life and Work*, London, 1903, p. 424. Salusbury's translation of the *Dialogue* was printed in 1661.

Systems of the World. This or some other translation was mentioned to Galileo by an English traveler, perhaps Hobbes, in 1633. Galileo and two of his friends are the speakers in *Astrologorum Concessus,* one of a series of essays by George Fortesque, entitled *Feriae Academicae,* which appeared in London in 1630. Hence it is possible that Milton visited Galileo partly as a result of interest in the astronomer's writings.

Yet even in mentioning his visit, in the *Areopagitica,* he does not assert his belief that Galileo was right. However, his purpose was not to uphold the correctness of any particular opinions, but to declare that all should be tolerated. He had no occasion for announcement—against the convictions of a large number of his English readers—that he held the views of Galileo. And if he did hold them, he did not make them a matter of conscience, or insist on propagating them. On the contrary, he seems to have acted as though Galileo's theories were not established, for after his return from Italy he apparently taught the old astronomy in his school. His pupils read the *Astronomica* of Manilius, an Augustan poet, and used as a text-book a popular manual by Joannes de Sacrobosco, entitled *De Sphaera Mundi.* Unless Milton supplemented this by explanations of his own, his pupils gained no knowledge of the Copernican system.[10]

Moreover, his casual references in his prose writings are not Copernican. In *Tetrachordon* (1645) we read:

> Nature hath her Zodiac also, keeps her great annual circuit over human affairs as truly as the sun and the planets in the firmament, hath her anomalies, hath her obliquities in ascensions and declinations, accesses and recesses, as blamelessly as they in heaven.[11]

Elsewhere[12] he speaks of "comets and impressions in the air." Galileo held that comets were not heavenly bodies but atmospheric phenomena,[13] vapors which rose from the earth to a great height, even above the moon, "without meeting any obstacle in the impenetrability of the Peripatetic sky" which he believed "more yielding and thin than our air."[14] Hence Milton's "impressions in the air," as well as the "aerial vapors"[15] like which souls rose to the Limbo of Vanities, may have come from Galileo. In *The Doctrine and Discipline of Divorce* Milton remarks of attempts to explain the words of Jesus in Matthew 19. 8-9:

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[10] Even the supplementary matter in the editions of *De Sphaera Mundi* that I have examined contains no Copernican teachings.

[11] P. 248, edition cited, vol. 4.

[12] *Of Reformation in England,* book 2, p. 45, edition cited, vol. 3.

[13] Fahie, *Galileo,* p. 181.

> Both which are too foul hypotheses to save the phenomena of our Savior's answer to the Pharisees about this matter. And I trust anon by the help of an infallible guide to perfect such Prutenick Tables as shall mend the astronomy of our wide expositors.[16]

The Prutenic Tables were made by Erasmus Reinhold, "who, although not admitting the Earth's motion, professed a great admiration for the system of Copernicus, and used it in computing new astronomical tables, the 'Prutenicae Tabulae' (1551), which were largely instrumental in introducing to astronomers the kinetic combinations originated by Copernicus. The 'Prutenicae Tabulae' were especially employed by the commission which in 1582 effected the Gregorian reform of the calendar. Whilst not believing in the Earth's motion, the members of this commission did not hesitate to use tables founded on a theory of the precession of the equinoxes and attributing a certain motion to the earth."[17] Hence, to use the Prutenic Tables was not of necessity to adhere to Copernicus.

Passing from Milton's prose writings to *Paradise Lost,* we find that though Galileo receives high honor, the astronomical references of the poems are not chiefly Copernican. Some are neutral, neither Ptolemaic nor Copernican, many clearly Ptolemaic, and a less, though considerable, number as clearly Copernican. In addition, Milton debates the merits of the two systems.

Of his neutral references, some are popular, as when he writes, just as we now might:

> The setting sun
> Slowly descended, and with right aspect
> Against the eastern gate of paradise
> Levelled his evening rays.[18]

Some show classical influence, as when we read that

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[14] *Dialogo,* p. 60.
[15] *P. L.* 3. 445.
[16] Book 1, chap. 2.
[17] Professor Pierre Duhem, *Catholic Encyclopedia* 9. 54.
[18] *P. L.* 4, 540-3.

the sun
Declined was hasting now with prone career
To th' Ocean Isles.[19]

The form of the following is determined by the Bible:

The sun shall in mid heaven stand still
A day entire, and night's due course adjourn,
Man's voice commanding, Sun in Gibeon stand.[20]

Some are indeterminate, and would be acceptable either to Ptolemy or Copernicus. Of this sort is Milton's conception of the universe as limited and globular.

A considerable number of passages are clearly Ptolemaic; the following are representative. Milton says of the souls which rise from earth as they pass toward the Limbo of Vanities:

They pass the planets seven, and pass the fixt,
And that crystalline sphere whose balance weighs
The trepidation talked, and that first moved.[21]

These are the ten spheres of the old astronomy. In their morning hymn Adam and Eve show familiarity with the Ptolemaic scheme:

Thou Sun, of this great world both eye and soul,
Acknowledge him thy greater, sound his praise
In thy eternal course, both when thou climb'st,
And when high noon hast gained, and when thou fall'st.
Moon, that now meetst the orient sun, now fli'st
With the fixt stars, fixed in their orb that flies,
And ye five other wandring fires that move
In mystic dance not without song, resound
His praise.[22]

Adam is also a Ptolemaic when he attempts to induce Raphael to prolong his visit by saying:

Scarce the sun
Hath finished half his journey, and scarce begins
His other half in the great zone of heaven.[23]

In describing the angelic dance Raphael uses a Ptolemaic illustration:

Mystical dance, which yonder starry sphere
Of planets and of fixt in all her wheels

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[19] *Ibid.* 4. 352-4.
[20] *Ibid.*, 12. 263-5.
[21] *Ibid.*, 3. 481-3.
[22] *Ibid.*, 5. 171-9.
[23] *Ibid.*, 5. 558-60.

Resembles nearest, mazes intricate,
Eccentric, intervolved, yet regular then
Most, when most irregular they seem.[24]

In telling of the creation he makes the sun

jocund to run
His longitude through heaven's high road,

and says of the moon:

Less bright the moon
But opposite in levelled west was set,
His mirror with full face borrowing her light
From him, for other light she needed none
In that aspect, and still that distance keeps
Till night. Then in the west her turn she shines,
Revolved on heaven's great axle.[25]

Here we have not merely the revolution of all the heavens about the earth, but also the conception of the moon as smooth and polished like a mirror. This was a Peripatetic belief. Satan is also a Ptolemaic; he thus addresses the earth:

Terrestrial heaven, danced round by other heavens
That shine, yet bear their bright officious lamps,
Light above light, for thee alone, as seems,
In thee concentring all their precious beams
Of sacred influence. As God in heaven
Is centre, yet extends to all, so thou
Centring receiv'st from all these orbs.[26]

These and other passages that might be added show that Milton naturally and easily wrote in Ptolemaic terms.

But over against these are expressions of Copernicanism the more striking in number because both popular and poetic usage were on the other side. Milton often refers to the telescope with approval, yet at the time of its invention some of the Aristotelians refused even to look through the instrument, and others declared that it was deceptive.[27] In his *Dialogue* Galileo makes the Peripatetic say:

> Nè ho sin qui prestato molta fede all'occhiale novamente introdotto; anzi, seguendo le pedate degli altri filosofi peripatetici miei consorti, ho creduto esser fallicie e inganni dei cristalli quelle che altri hanno ammirate per operazioni stupende.[28]

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[24] *Ibid.*, 5. 620-4.

[25] *Ibid.*, 7. 372-81.

[26] *Ibid.*, 9. 103-9.

[27] Fahie, pp. 100 ff.

[28] *Dialogo*, p. 366.

Milton's complete acceptance of the telescope is a long step toward approval of the Galilean astronomy, which depended on telescopic demonstrations.

Milton follows the new astronomy in describing the moon:

> The moon, whose orb
> Through optic glass the Tuscan Artist views
> At evening from the top of Fesole,
> Or in Valdarno, to descry new lands,
> Rivers or mountains in her spotty globe.[29]

The rough and irregular character of its surface was one of the matters on which Galileo insisted against the followers of Aristotle. He discusses the subject at length, and describes many experiments proving that if the surface of the moon were like a mirror it could not give light as it does.[30] Many of the eminences of the moon were, he writes, "simili alle nostre più aspre e scoscese montagne."[31] He speaks also of the "piazze" of the moon, and of open spaces more and less shining. In mentioning "rivers" Milton is not following Galileo, who held that there was no water on the moon.[32]

The sun-spots to which Milton compares Satan (*P. L.* 3. 588) were phenomena to which Galileo had given much study. About the time he discovered them they were also observed by Christopher Scheiner, a Jesuit father, who explained them as little planets moving around the sun within the orbit of Mercury. Others made them "vane illusioni de cristalli" in the telescope. Galileo came to the conclusion that the spots were attached to the solar disc, and that their motion was caused by the rotation of the sun. Having established this, he pointed out that the apparent movements of the spots could be caused only by movements of the earth.[33] Milton seems to accept Galileo's observations and conclusions in the passage:

> A spot like which perhaps
> Astronomer in the sun's lucent orb
> Through his glazed optic tube yet never saw.[34]

The logical conclusion of this belief is acceptance of the motions of the earth.

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[29] *P. L.* 1. 287-91.
[30] *Dialogo*, pp. 78 ff.
[31] *Ibid.*, p. 72.
[32] *Ibid.*, p. 112.
[33] *Dialogo*, pp. 60 ff., 375 ff., 384.
[34] *P. L.* 3. 588-90.

Some of Milton's expressions about the earth itself are also in the manner of Galileo. In describing the creation he wrote:

> Earth self-balanced on her centre hung.[35]

Galileo considers the earth a "corpo pensile e librato sopra'l suo centro," [36] and as "sospesa e librata nella circonference dell' orbe magno" of its orbit. Milton also makes the earth one of the heavenly bodies. Satan in looking on the universe for the first time asks:

> In which of all these shining orbs hath man
> His fixed seat, or fixed seat hath none,
> But all these shining orbs his choice to dwell? [37]

Uriel answers:

> Look downward on that globe whose hither side
> With light from hence, though but reflected shines;
> That place is earth, the seat of man.[38]

Galileo's opponents denied that the earth could shine like the other heavenly bodies, but he was convinced that it was illumined by the sun and gave off light in the same manner as the moon.[39] Indeed, he makes it one of the planets, as Milton tells that Raphael saw it as he descended,

> Not unconform to other shining globes.[40]

This may mean no more than that the earth gave off light as did the moon. Yet perhaps Milton had its motion also in mind, for Galileo used the similarity of the earth to the planets in its reflection of light to establish a probability that it must like them be mobile, while the sun and fixed stars, which shine with their own light, do not revolve.[41]

One of Galileo's discoveries was that the planet Venus goes through phases like those of the moon, and consequently shines by light reflected from the sun. He also inferred from her phases that she revolved about the sun. To her crescent shape and reflected light Milton refers in the lines:

> Hither as to their fountain other stars

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[35] *P. L.* 7. 242.
[36] *Dialogo*, p. 135.
[37] *P. L.* 3. 668-70.
[38] *Ibid.*, 3. 722-4.
[39] *Dialogo*, p. 76, 80, 108.
[40] *P. L.* 5. 259.
[41] *Dialogo*, p. 290.

> Repairing, in their golden urns draw light,
> And hence the morning planet gilds his horns.[42]

It is unlikely that Milton did not accept the necessary conclusion, indicated by Galileo,[43] that the planet revolved about the sun. Galileo explains that Copernicus, unable, without the telescope, to see the phases of Venus, and hence believing her always round, thought that "la sua materia fusse tale che potesse imbeversi del lume solare e quello trasmettere per tutta la sua profondità, sì che potesse mostrarcisi sempre resplendente." [44] Milton echoes these words when he speaks of the sun as

> made porous to receive
> And drink the liquid light, firm to retain
> Her gathered beams.[45]

Yet curiously enough in this context Milton speaks of the "small peculiar" light of the planets—something in which Galileo did not believe. The Peripatetics held that the moon had a small amount of light of her own,[46] pointing out that her entire disc was visible when only part of it was brightly illuminated. This Galileo [47] attributed to light reflected from the earth, and not to light peculiar to the moon. Continuing, Milton speaks of the light of the stars as

> from human sight
> So far remote, with diminution seen.[48]

Perhaps this is based on Galileo's statements about the apparent size of the planets. When observed with the naked eye, Venus sometimes appears eight or ten times larger than Jupiter, but when observed through the telescope, the disc of Jupiter appeared four or more times larger, "ma la vivacità dello splendor di Venere era incomparabilmente maggiore della luce languidissima de Giove; il che da altro non procedeva, che dall' esser Giove lontanissimo dal Sole e da noi, e Venere vicina a noi e al Sole." [49]

The ancient idea that the fixed stars were fastened on their sphere as on a ceiling had been abandoned by the Peripatetics, who held that there were two concentric spheres between which the fixed stars were placed at varied distances from the earth. Galileo made this sphere of extent so vast as practically to destroy it, holding that some of the stars were " dúe e tré volte più remote di alcune altre." [50] He also discussed the possibility that the fixed stars possessed motion somewhat like that of the planets.[51] He held it more probable, however, that they were truly fixed, and did not "go wandering" each for itself, even though he also believed that the sky was not solid, but fluid, so as to permit free motion. The fixed stars were of vast size, much greater than the earth;[52] Galileo speaks of them as suns,[53] not less resplendent than the sun itself with their own peculiar light. Something of this may appear in Milton's description of the flight of Satan through the heaven of the fixed stars;

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[42] *P. L.* 7. 364-6.

[43] *Dialogo*, p. 364.

[44] *Dialogo*, p. 364.

[45] *P. L.* 7. 361.

[46] *Dialogo*, pp. 78 ff.

[47] *Ibid.*, p. 76.

[48] *P. L.* 7. 368-9.

[49] *Dialogo*, p. 369.

> From pole to pole
> He views in breadth, and without longer pause
> Down right into the world's first region throws
> His flight precipitant, and winds with ease
> Through the pure marble air his oblique way
> Amongst innumerable stars, that shone
> Stars distant, but nigh hand seemed other worlds.[54]

Galileo by means of the telescope had learned that the number of the stars was much greater than had been supposed, and that the Milky Way, hitherto a "matter of controversy among philosophers," [55] was made up of stars indistinguishable by the naked eye. Milton's reference is wholly Galilean:

> that milky way
> Which nightly as a circling zone thou seest
> Powdered with stars.[56]

These passages show that Milton took as a matter of course various beliefs from the new astronomy; this familiarity with its details suggests that he believed in its general principles. Yet the transition between the old and the new was so gradual that any or all of Milton's evident Copernican beliefs might be favorably regarded by one not prepared to make the final assertion of the mobility of the earth and the fixed position of the sun. Milton nowhere takes this for granted or asserts it; he mentions it always as something possible, but yet hypothetical, and a subject for debate.

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[50] *Ibid.*, p. 415.

[51] *Ibid.*, p. 415.

[52] *Dialogo*, p. 297.

[53] *Ibid.*, p. 356.

[54] *P. L.* 3. 560-6.

[55] Galileo's Letter to Belisario Vinta, quoted by Fahie, p. 86.

[56] *P. L.* 7. 579-81.

In several passages the poet or one of his characters explains some astronomical matter according to both old and new systems, without deciding that either is true. The most considerable of these debates is that into which the Angel Raphael is led by the questions of Adam.[57] In thus presenting the matter as debatable, Milton has truly represented his age, which halted between two opinions. In setting the two systems over against one another, he has followed the most representative astronomical work of his day, Galileo's *Dialogo intorno ai due massimi sistemi del mondo tolemaico e copernicano.* The beginning of the Eighth Book of *Paradise Lost* is an untechnical summary of this work, by a master of compression who caught the spirit of that with which he dealt. Few will read Galileo's *Dialogue,* and indeed few need to, so long as we have *Paradise Lost,* for Milton has represented Galileo with such understanding and skill that the astronomical part of *Paradise Lost* shows the poet at his best in his function of giving permanent form to the spirit of his age.

Galileo published his *Dialogue* [58] in the year 1632, with the purpose of exhibiting the points at issue between the old and the new astronomy, and showing the superiority of the new. It was written with great caution, for the Copernican system was not acceptable to the authorities of the Church, and Galileo's earlier works had rendered him an object of suspicion to the Inquisition. Hence the author does not state plainly the truth of the Copernican system, and does not represent the upholder of the Peripatetic astronomy as convinced of his errors. Yet even when allowance is made for Galileo's too-well-founded fears of the Inquisition, something of the undogmatic character of the work can still be attributed to the modesty of the author in the face of matters which he in his wisdom knew that he was ignorant of. About what he has actually observed Galileo is sure enough; doubts appear only when observation ceases.

The Copernican side of the discussion is upheld by Salviati, who represents Galileo's opinions. The character of an eager but critical enquirer into the truth, friendly to the new astronomy, is sustained by Sagredo. The Peripatetics are represented by Simplicio, who clings to the old beliefs, though he does not appear wholly unreceptive.

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[57] *Ibid.,* 8. 1-198.

[58] It occupies five hundred pages in the edition of 1842.

But whether or not Galileo's enforced respect for the Inquisition led to essential alterations in his *Dialogue,* Milton in following the scientist takes him at his word, as though he had no doubt that Galileo was putting forth his genuine sentiments. Indeed, in *Paradise Lost* the poet gives more weight to the side of Ptolemy than Galileo allows it. Not merely is Milton's discussion like that of Galileo in employing the form of the dialogue, but many of the details are also similar. A verbal resemblance between *Paradise Lost* and the Italian work is, indeed, not proof of borrowing, for Milton had read other books on astronomy, but all the circumstances make clear Milton's familiarity with this—the chief representative of its type—even though he took from other sources or developed for himself part of what he might have found in it.

The first suggestion of astronomical uncertainty in *Paradise Lost* occurs in Milton's description of Satan's flight into the universe from the foot of the stairs leading up to the Empyrean Heaven. Satan plunges down into the "world's first region"—that of the fixed stars—and bends his course toward the sun,

> but up or down
> By centre, or eccentric, hard to tell,
> Or longitude, where the great luminary
> Aloof the vulgar constellations thick,
> That from his lordly eye keep distance due,
> Dispenses light from far; they as they move
> Their starry dance in numbers that compute
> Days, months, and years, towards his all-cheering lamp
> Turn swift their various motions, or are turned
> By his magnetic beam.[59]

The doubt here is concerning the position of the sun in the universe; will Satan reach it by going toward the centre of the world; or is it out of the centre, and if so in what direction? In this—the chief matter of debate between Copernicans and Ptolemaics—Milton will not express an opinion. As to some lesser matters, the distance of the fixed stars from the sun is discussed in Galileo's

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[59] *P. L.* 3. 574-583.

Dialogue. Salviati believed that some of them were much farther removed than others, and that all were at an almost incredible distance, so far that annual movements of the earth, very evident in Saturn, would not be noticeable in the fixed stars.[60] This, with its assumption of a great interval between Saturn and the fixed stars, is unacceptable to Simplicio,[61] though he is willing to admit that the fixed stars are far away. The remainder of Milton's passage is apparently confused. He speaks of the "starry dance" as though attributing it to the fixed stars; this, however, is unlikely; as the name of these stars indicates, their motion was held to be only with the sphere containing all of them. On the other hand, the movement of the planets is often called a dance.[62] Whether the earth is to be included among these dancing bodies is not stated. Consistency with line 722 might require it, but it is hardly probable that Milton here intended to imply that the earth revolved about the sun. The Ptolemaics were aware that the other planets moved about the sun;[63] hence the passage is not of necessity Copernican. At its end comes a further alternative: the planets move either of themselves, or as a result of the "magnetic beam" of the sun. Galileo speaks of the natural motion of the heavenly bodies, which, because of their perfection, is circular. This motion came from God. Galileo makes no attempt to account for the celestial movements by anything like gravitation. He was, however, familiar with the work of the father of magnetic studies, William Gilbert. When Simplicio asks Salviati whether he is one of the adherents to the magnetic philosophy of Gilbert, he answers: "Sono per certo."[64] He makes use of the magnetic theory to explain that the earth maintains its position as does the magnetic needle, but does not suggest magnetic relations with other heavenly bodies. In fact Galileo does not attempt a scientific explanation of the relations of the heavenly bodies. Yet in *De Magnete,* which Galileo probably read in 1602, Gilbert suggests magnetic relations between the earth and the moon. It is probable that Milton knew of the writings of Gilbert, and derived thence his conception of the magnetic influence of the sun.

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[60] *Dialogo,* p. 390.
[61] *Ibid.,* p. 399.
[62] E. g., *P. L.* 5. 178.
[63] *Dialogo,* pp. 353 ff., 371.
[64] *Dialogo,* p. 433.

In his account of the alterations made in the earth in order to change its equable climate after the fall of man, Milton again presents an astronomical uncertainty:

> Some say he bid his angels turn askance
> The poles of earth twice ten degrees and more
> From the sun's axle; they with labor pushed
> Oblique the centric globe: some say the sun
> Was bid turn reins from th'equinoctial road
> Like distant breadth.[65]

Here the question is between sun and earth. The second alternative is Ptolemaic in that it involves the motion of the sun. The first, with its adaptation of earth to sun, perhaps implies that the sun is the centre of the universe.[66] This problem of the inclination of the axis of the earth was debated by Galileo's characters. Sagredo says:

> Il Copernico pone la sfera stellata immobile e il Sole nel centro di essa parimente immobile. Adunque ogni mutazione che a noi apparisca farsi nel Sole o nelle Stelle fisse, è necessario che sia della Terra, cioè nostra. Ma il Sole si alza e si abbassa nel nostro meridiano per un arco grandissimo, quasi di 47 gradi, e per archi ancora maggiori e maggiori varia le sua larghezze ortive e occidue negli orizzonti obliqui: or come può mai la Terra inclinarsi e rilevarsi tanto notabilmente al Sole, e nulla alle Stelle fisse, o per si poco, che sia cosa impercettibile? Questo è quel nodo che non è possuto mai passare al mio pettine.[67]

Salviate later explains in detail, saying in part:

> E qui e da notare un accidente maraviglioso, che è: che siccome il conservar l'asse della Terra la medesima direzione verso l'Universo, o vogliamo dire verso la sfera altissima delle Stelle fisse; fa che il Sole ci appare elevarsi e inclinarsi per tanto spazio, cioè per gradi 47, e niente inclinarsi o elevarsi le Stelle fisse, così all'incontro, quando il medesimo asse della Terra si mantenesse continuamente con la medesima inclinazione verso il Sole, o vogliam dire verso l'asse del Zodiaco, nessuna mutazione apparirebbe farsi nel Sole circa l'alzarsi e abbassarsi; onde gli abitatori dell'istesso luogo sempre avrebbero le medesime diversità dei giorni e delle notti, e la medesima costituzione di stagioni, cioè altri sempre Inverno, altri sempre State, altri Primavera, ec.[68]

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[65] *P. L.* 10. 668-73.

[66] "Centric" (line 671) probably means not *central*, but *having a centre;* cf. *P. L.* 7. 242.

[67] *Dialogo*, p. 411.

[68] *Dialogo*, p. 427.

In a third passage Milton comes to the chief point at issue, speaking of

> the Sun now fallen
> Beneath th'Azores; whither the prime orb
> Incredible how swift, had thither rolled
> Diurnal, or this less volubil earth
> By shorter flight to th'east, had left him there.[69]

Here he merely states the difference, with no attempt to debate it. Yet he gives indications that he was familiar with the arguments on either side. Galileo[70] has Simplicio tell of a machine moving so slowly as to make but one revolution in twenty-four hours. Yet if the semi-diameter were prolonged to the sun, the velocity of an object at its end would be very great. Hence the earth is called "less voluble," that is, less swiftly turning, than the sun. Galileo often refers to the argument that the heavenly bodies would be forced to "una celerità incomprensibile"[71] in order to revolve about the earth, while the earth could bring day and night by a less rapid movement.

In the passages indicating astronomical doubt thus far mentioned, the poet has spoken in his own person, revealing his uncertainty or his deference to both of the opposite opinions. In the longest and most important passage the chief speaker is the Angel Raphael, sent from heaven to answer Adam's "desire of knowledge." Hence it is probable that his words represent what seemed to Milton the truth. We observe that they bear close affinity to the *Dialogue* of Galileo.

Adam opens the conversation by speaking of the world as a "goodly frame." The word "frame," meaning fabric or structure, a favorite of Milton's, is similar to Galileo's "macchina,"[72] which appears in the following passage, spoken by Simplicio:

> A che fine e a benefizio di chi sono macchine tanto vaste? prodotte forse per la Terra, cioè per un picciolissimo punto? e perchè tanto remote acciocchè appariscano tantine, e niente assolutamente possa operare in

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[69] *P. L.* 4. 591-5.

[70] *Dialogo*, p. 293.

[71] *Dialogo*, p. 429.

[72] See also p. 430. For the force of the word, compare Wordsworth's "the very pulse of the machine" (*She was a phantom of delight* 22). Milton uses the expression "machina mundi" in his poem *Naturam non pati senium* 69. It often occurs in the *De Sphaera* of Joannes de Sacrobosco (*e. g.*, p. 4, edition of Paris, 1608), the textbook of astronomy used by Milton's pupils.

Terra? e a che proposito una spropositata immensa voragine tra esse e Saturno? frustratorie sono tutte quelle cose, che da ragioni probabili non son sostenute.[73]

This is Adam's thought of the trivial appearance of the earth in comparison with the size of the heavens:

> When I behold this goodly frame, this world
> Of heaven and earth consisting, and compute
> Their magnitudes, this earth a spot, a grain,
> An atom, with the firmament compared
> And all her numbered stars, that seem to roll
> Spaces incomprehensible (for such
> Their distance argues and their swift return
> Diurnal) merely to officiate light
> Round this opacous earth, this punctual spot,
> One day and night; in all their vast survey
> Useless besides, reasoning I oft admire,
> How nature wise and frugal could commit
> Such disproportions.[74]

With Milton's firmament and her "numbered," that is, numerous,[75] stars, we may compare Galileo's "Cielo altissimo . . . che seco porti l'innumerabil moltitudine delle stelle fisse, corpi tutti vastissimi e maggiori assai della Terra, e di più tutte le sfere dei pianeti, ancorchè e questi e quelle per lor natura si muovano in contrario." [76] Milton's "spaces incomprehensible" remind us of Simplicio's statement:

> Non si nega che'l Cielo non possa superare di grandezza la nostra immaginazione, come anco l'aver potuto Dio crearlo mille volte maggiore di quello che è.[77]

The diurnal movement of the distant fixed stars as a proof of the immensity of their orbits, suggests Salviati's words:

> Quando si voglia ritener la Terra immobile, è necessario, dopo l'esser passati dal periodo brevissimo della Luna agli altri conseguentemente maggiori, sino a quel di Marte in due anni, e di lì a quel della maggiore sfera di Giove in anni dodici, e da questa all'altra maggiore di Saturno,

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[73] *Dialogo*, p. 402. For similar expressions, see pp. 128-9, 135, 389.

[74] *P. L.* 8. 15-27.

[75] This sense is not given in the *New English Dictionary*, but I believe it correct here. Cf. *P. L.* 3. 565; 5. 745.

[76] *Dialogo*, p. 134.

[77] *Ibid.*, p. 399. Cf. p. 429.

> il cui periodo è di trent anni, è necessario, dico, trapassare ad un'altra sfera incomparabilmente maggiore, e farla finire una intera revoluzione in ventiquattr'ore.[78]

The function of the stars as "merely to officiate light" to the earth, and as otherwise useless, is also mentioned by Simplicio:

> Ma quanto queste condizioni arrecano di nobilità alla Terra, altretanto renderebbero i corpi celesti più imperfetti, nei quali esse sarebbero superflue; essendo che i corpi celesti, cioè il Sole, la Luna e l'altre stella, che non sono ordinati al altro uso, che al servizio della Terra, non hanno bisogno d'altro per conseguire il loro fine, che del moto e del lume.[79]

That the earth is, as Adam says, "opacous," that is, not luminous, was the firm belief of Simplicio. Salviate, on the other hand, though admitting that the earth was "per sè stessa oscura e opaca," thought that through her "opacità" she was the more "atta a ricevere e a ripercuotere il lume del Sole." [80]

Adam's admiration, as he reasons on the disproportion between the earth and the vast heavens, is that of some of Galileo's characters. Indeed his chief argument against the Ptolemaic system is that one must "admire" its disproportion. Salviati asks:

> Ora, se per conseguire il medesimo effetto *ad unguem*, tanto fa se la sola Terra si muova, cessando tutto il resto dell'universo, che se, restando ferma la Terra sola, tutto l'universo si muova di un intesso moto, chi vorrà credere che la natura (che pur per commun consenso non opera con l'intervento di molte cose quel che si può fare col mezzo di poche) abbia eletto di far muovere un numero immenso di corpi vastissimi, e con una velocità inestimabile, per conseguir quello che col movimento mediocre di un solo intorno al suo proprio centro poteva ottenersi? [81]

This conception of "nature wise and frugal" is accepted by both parties. Simplicio is equally sure "che la natura non manca nè soprabbonda nelle cose necessarie." [82] The nobility of the celestial bodies was firmly maintained by Simplicio, who speaks of them as "ingenerabili, incorruttibili, inalterabili," [83] and "di tanto nobilità" that they are wholly different from the earth, which is a

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[78] *Ibid.*, p. 133. Cf. pp. 129, 131.

[79] *Dialogo*, p. 68. Cf. pp. 399-400.

[80] *Ibid.*, p. 72. Cf. p. 181, *infra.*

[81] *Dialogo*, p. 130. Cf. pp. 68, 138, 429.

[82] *Ibid.*, p. 821. Cf. pp. 68, 69, 399-400, 429.

[83] *Ibid.*, p. 54. Cf. pp. 23, 41, 68, 96.

"sentina di tutte le materie corrutibili." [84] Adam's idea, common in popular astronomy, that "number fails" to describe the swiftness of the stars is applied by Salviati to their distance:

> Vorrei, signor Simplicio, che, sospesa per un poco l'affezione che voi portate ai seguaci della vostra opinione, mi diceste sinceramente, se voi credete che essi nella mente loro comprendano quella grandezza, che dipoi giudicano non poter per la sua immensità attribuirsi all'Universo; perchè io, quanto a me, credo di no: e mi pare che siccome nell'apprension de'numeri, come si comincia a passar quelle miglia di millioni l'imagination si confonde, nè può più formar concetto, così avvenga ancora nell'apprender grandezze e distanze immense, sì che intervenga al discorso effetto simile a quello che accade al senso, che mentre nella notte serena io guardo verso le Stelle, guidico al senso la lontananza loro esser di poche miglia, nè esser le Stelle fisse punto più remote di Giove o Saturno, anzi pur nè della Luna.[85]

After Adam has spoken, the angel takes up the discourse, first commending Adam for his desire to read the heavens as "the book of God," and thus confirming Adam's earlier saying, when he asked Raphael for information:

> We, not to explore the secrets ask
> Of his eternal empire, but the more
> To magnify his works, the more we know.[86]

This is in harmony with Salviati's thought of seeking out "la ricchezza della natura e l'omnipotenza del Creatore e Governatore." [87] And in Galileo's dedication to Ferdinando de' Medici, he writes:

> Il volgersi al gran libro della Natura, che è il proprio oggetto della filosofia, è il modo per alzar gli occhi: nel qual libro, benche tutto quel che si legge, come fattura d'artefice omnipotente, sia per ciò proportionatissimo, quello nientedimeno è più spedito e più degno, ove maggiore al nostro vedere apparisce l'opera e l'artifizio.[88]

In the mouth of Sagredo he puts the declaration:

> Io stimerei . . . la natura aver fatte prima le cose a suo modo, e poi fabbricati i discorsi umani abili a poter capire (ma però con fatica grande) alcuna cosa de'suoi segreti.[89]

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[84] *Ibid.*, p. 291. [85] *Dialogo*, p. 398. [86] *P. L.* 7. 95-7.

[87] *Dialogo*, p. 114. Cf. p. 117.

[88] *Ibid.*, p. 9.

[89] *Ibid.*, p. 288.

Milton felt, however, that God had given man but a partial understanding of nature:

The rest
From man or angel the great architect
Did wisely to conceal, and not divulge
His secrets to be scanned by them who ought
Rather admire; or if they list to try
Conjecture, he his fabric of the heavens
Hath left to their disputes, perhaps to move
His laughter at their quaint opinions wide.[90]

Galileo also realized that astronomy had not progressed far:

> Molto ragionevolmente dubitate, e io, all'instanza rispondendo, dico, che, benche l'astronomia nel corso di molti secoli abbia fatto gran progressi nell'investigar la costituzione e i movimenti dei corpi celesti, non però è ella sin qui arrivata a segno tale che moltissime cose non restino indecise, e forse ancora molt'altre occulte.[91]

Hence he has Salviate rebuke Simplicio for thinking fully to understand the book of nature:

> Finalmente io ti domando, o uomo sciocco: Comprendi tu con l'immaginazione quella grandezza dell'universo, la quale tu giudichi poi esser troppo vasta? Se la comprendi, vorrai tu stimare che la tua apprehensione si estenda più che la Potenza Divina? Vorrai tu dir d'immaginarti cose maggiori di quelle, che Dio possa operare? Ma se non la comprendi, perchè vuoi apportar giudizio delle cose da te non capite?[92]

Continuing, Milton represents the divine architect as moved to laughter at the attempts of astronomers to "save appearances." This expression, a translation of the Greek *σώζειν τὰ φαινόμενα*, was the stock expression of Renaissance astronomers for the construction of hypotheses to account for what they saw in the heavens. A scholar of our day comments on the conception as follows:

> Copernicus and his disciple Rhaeticus very probably regarded the motions which their theory ascribed to the Earth and the planets, the sun's rest and that of the firmament of fixed stars, as the real motions or real rest of those bodies. The "De Revolutionibus Orbium Caelestium Libri Sex" appeared with an anonymous preface which inspired an entirely different idea. This preface was the work of the Lutheran theologian Osiander (1498-1552), who therein expressed the opinion that the hypotheses expressed by philosophers in general, and Copernicus in particular, were in

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[90] *P. L.* 8. 71-8.

[91] *Dialogo*, p. 492.

[92] *Ibid.*, p. 399. Cf. p. 114.

> no wise calculated to acquaint us with the reality of things: " Neque enim necesse est eas hypotheses esse veras, imo, ne verisimiles quidem, sed sufficit hoc unum si calculum observationibus congruentem exhibeant." Osiander's view of astronomical hypotheses was not new. Even in the days of Grecian antiquity a number of thinkers had maintained that the sole object of these hypotheses was to save appearances, *σώζειν τὰ φαινόμενα*, and in the Middle Ages, as well as in antiquity, this method continued to be that of philosophers who wished to make use of Ptolemaic astronomy whilst at the same time holding the Peripatetic physics absolutely incompatible with this astronomy. Osiander's doctrine was therefore readily received first of all by the astronomers who, without believing the Earth's motion to be a reality, accepted and admired the kinetic combinations conceived by Copernicus, as these combinations provided them with better means than could be afforded by the Ptolemaic system for figuring out the motion of the moon and the phenomena of the precession of the equinoxes.[93]

Galileo frequently employs the expression " save the phenomena," as when Salviati says that he is able " agevolmente salvar tante stravaganti apparenze nei movimenti delle macchie solari," [94] or that he can give " adequate ragioni di tutte quelle medesime apparenze." [95] Hence we may infer that in *Paradise Lost,* as in the *Doctrine and Discipline of Divorce,*[96] Milton uses the word in its sober scientific meaning.

Raphael's somewhat comic account of the means employed to save appearances—" centric and eccentric," " cycle and epicycle, orb in orb "—is also Galilean:

> Ma che diremo noi dell'apparente movimento dei pianeti tanto difforme, che non solamente ora vanno veloci e ora più tardi, ma talvolta del tutto si fermano, e anco dopo per molto spazio ritornano indietro? per la quale apparenza salvare, introdusse Tolomeo grandissimi Epicicli, adattandone un per uno a chiascedun pianeta con alcune regole di moti incongruenti, li quali tutti con un semplicissimo moto della Terra si tolgono via.[97]

In giving the progress of astronomical study, Salviati remarks:

> Molti più anni e da credere che passassero avanti che fossero osservate le stazioni e retrogradazioni dei tre superiori, come anco gli accostamenti e discostamenti dalla Terra, occasioni necessarie dell'introdur gli Eccen-

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[93] Pierre Duhem, *Catholic Encyclopedia* 9. 54.

[94] *Dialogo*, p. 386.

[95] *Ibid.*, p. 429. Cf. pp. 97, 132, 356, 366, 368, 372, 429, 455, 479.

[96] P. 156, *supra.*

[97] *Dialogo*, p. 373.

trici e gli Epicicli, cose incognite sino ad Aristotile, giacchè ei non ne fa menzione.[98]

A chief cause of Adam's wonder about the universe is that

> Nature wise and frugal could commit
> Such disproportions, with superfluous hand
> So many nobler bodies to create,
> Greater so manifold to this one use,
> For aught appears, and on their orbs impose
> Such restless revolution day by day
> Repeated, while the sedentary earth,
> That better might with far less compass move,
> Served by more noble than herself, attains
> Her end without least motion.[99]

On the question of the relative nobility of the earth and the heavenly bodies, the angel suggests to Adam that

> the earth
> Though, in comparison of heaven so small,
> Nor glistering, may of solid good contain
> More plenty then the sun that barren shines,
> Whose virtue on itself works no effect,
> But in the fruitful earth; there first received
> His beams, unactive else, their vigor find.[100]

This matter is discussed at length in the *Dialogo.* Simplicio holds that the celestial bodies, as a sign of their perfection, are unalterable, and hence without generation. Sagredo, however, thinks that it would add to their perfection if they produced something:

> Se all'eternità dell'intero globo terrestre non è punto pregiudiziale la corruptibilità delle parti superficiali, anzi questo esser generabile, corrutibile, alterabile ec. gli arreca grand'ornamento e perfezione, perchè non potete, e dovete voi ammetter alterazioni, generazioni ec. parimente nelle parti esterne dei globi celesti, aggiugnendo loro ornamento, senza diminuirgli perfezione, o levargli le azione, anzi accrescendogliele, col far che non solo sopra la Terra, ma che scambievolmente fra di loro tutte operino, e la Terra ancora verso di loro? [101]

But Simplicio is sure that the heavenly bodies act only on the earth:

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[98] *Ibid.*, p. 492.
[99] *P. L.* 8. 26-35.
[100] *P. L.* 8. 91-7.
[101] *Dialogo*, p. 69.

> I corpi celesti, cioè il Sole, la Luna e l'altre stelle, che non sono ordinati ad altro uso, che al servizio della Terra, non hanno bisogno d'altro per conseguire il lor fine, che del moto e del lume.[102]

He declares further that there can be no generation on the moon, for such activity would be useless and vain, and it is the dictum of Aristotle that "natura nihil frustra facit." It would be vain,

> Perchè noi chiaramento veggiamo e tocchiamo con mano, che tutte le generazioni, mutazioni ec. che si fanno in Terra, tutte, o mediatamente, o immediatamente, sono indirizzate all'uso, al comodo, e al benefizio dell'uomo: per comodo degli uomini nascono i cavalli, per nutrimento de'cavalli produce la Terra il fieno, e le nugole l'adacquano; . . . in somma, se noi anderemo diligentemente esaminando e risolvendo tutte queste cose, troveremo il fine, al quale tutto sono indirizzate, esser il bisogno, l'utile, il comodo e il diletto degli uomini. Or di quale uso potrebber esser mai al genere umano le generazioni, che si facessero nella Luna o in altro pianeta? se già voi non voleste dire, che nella Luna ancora fussero uomini, che godesser de'suoi frutti; pensiero o favoloso o empio.[103]

This resembles the angel's suggestion:

> Yet not to earth are those bright luminaries
> Officious, but to thee earth's habitant.[104]

Man cannot, however, hope to know the use of the "heavens' wide circuit," it is

> Ordained for uses to his lord best known.[105]

Galileo was well aware of man's ignorance. Sagredo thinks that there may be in the heavenly bodies beings "non solamente diverse dalle nostre, ma lontanissime dalla nostra immaginazione, e in somma del tutto a noi inescogitabili." [106] Salviate replies:

> Io son molte volte andato fantasticando sopra queste cose, e finalmente me pare di poter ritrovar bene alcune delle cose, ce non sieno, nè possan esser nella Luna; ma non già veruna di quelle, che io creda che vi sieno e possano essere, se non con una larghissima generalità, cioè, cose che l'adornino operando e movendo e vivendo, e forse con modo diversissimo dal nostro, veggendo e ammirando la grandezza e bellezza del Mondo e del suo Facitore e Rettore, e con encomi continui cantando la sua gloria; e in somma (che è quello che io intendo) facendo quello tanto frequente-

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[102] *Ibid.*, p. 68.

[103] *Ibid.*, p. 69.

[104] *P. L.* 8. 98-9.

[105] *Ibid.*, 8. 106.

[106] *Dialogo*, p. 70.

mente dagli scrittori sacri affermato, cioè una perpetua occupazione di tutti le creature in laudare Iddio.[107]

This question of possible inhabitants in the heavenly bodies had occurred to Milton. He is unwilling to admit that the Limbo of Vanities is situated in the moon:

> Those argent fields more likely habitants,
> Translated saints, or middle spirits hold
> Betwixt th'angelical and human kind.[108]

The stars may also have their inhabitants; we read of Satan's flight among them:

> He . . . winds with ease
> Through the pure marble air his oblique way
> Amongst innumerable stars, that shone
> Stars distant, but nigh hand seemed other worlds, . . .
> Thrice happy isles, but who dwelt happy there
> He stayed not to enquire.[109]

The angel Raphael, suggesting to Adam the vast extent of the universe, says that the other planets which he perhaps will descry may be

> Stored in each orb perhaps with some that live.
> For such vast room in nature unpossesst
> By living soul, desert and desolate,
> Only to shine, yet scarce to contribute
> Each orb a glimpse of light, conveyed so far
> Down to this habitable, which returns
> Light back to them, is obvious to dispute.[110]

The angel employs the Copernican belief [111] that the earth, though inhabited, gives light to the stars, to raise a probability that the stars, which give light to the earth, are also inhabited, and not, as the Ptolemaics held,[112] incapable of producing anything.

But man should not expect to understand the mysteries of the heavens, for, as Sagredo humbly expresses it:

> Grandissima mi par l'inezia di coloro, che vorrebbero che Iddio avesse fatto l'Universo più proporzionato alla piccola capacità del lor discorso, che all'immensa, anzi infinita sua potenza.[113]

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[107] *Ibid.*, p. 71.
[108] *P. L.* 3. 460-2.
[109] *Ibid.*, 3. 561-71.
[110] *Ibid.*, 8. 152-8.
[111] See p. 169, *supra*, and p. 181, *infra*.
[112] P. 173, *supra*.
[113] *Dialogo*, p. 402. Cf. pp. 114, 399.

Continuing his thought that the uses of the heavens are known to God alone, the angel instructs Adam thus:

> The swiftness of those circles attribute,
> Though numberless, to his omnipotence,
> That to corporeal substances could add
> Speed almost spiritual.[114]

The idea of the effect of the spiritual on the material is Aristotelian, but is not brought forward by Simplicio. Galileo does not have his interlocutors discuss the cause of the heavenly movements further than to attribute them to nature and to God.[115]

Yet after Milton's angel has spoken "admitting motion in the heavens" he continues:

> Not that I so affirm, though so it seem
> To thee who hast thy dwelling here on earth.[116]

Similarly Salviati says:

> Eccovi . . . le ragioni potissime . . . che hanno relazione all'apparenze celesti, le quali ragioni tendon veramente più a dimostrar l'esser la Terra nel centro dell'universo, e a spogliarla in conseguenza del movimento annuo intorno ad esso attribuitogli dal Copernico, le quali, come di materia alquanto differente, si potranno produr dopo che avremo esaminata la forza di queste fin qui proposte.[117]

Raphael next passes directly to the question at issue:

> What if the sun
> Be centre to the world, and other stars
> By his attractive virtue and their own
> Incited, dance about him various rounds.[118]

The "attractive virtue" of the sun, as we have observed, is not mentioned in the *Dialogue,* though the movement of the heavenly bodies is spoken of as natural.[119] The wandering courses of the planets,

> now high, now low, then hid
> Progressive, retrograde, or standing still,[120]

are commonplaces of Ptolemaic astronomy. Galileo deals with them as such:

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[114] *P. L.* 8. 107-10.

[115] *Dialogo,* p. 126.

[116] *P. L.* 8. 117-18.

[117] *Dialogo,* p. 148.

[118] *P. L.* 8. 122-5.

[119] *Dialogo,* pp. 20 ff.

[120] *P. L.* 8. 126-7.

> In Tolomeo bisogna assegnare ai corpi celesti movimenti contrari, e far che tutti si muovano da levante a ponente, e insieme insieme da ponente verso levante; che nel Copernico son tutte le revoluzioni celesti per un sol verso, da occidente in oriente. Ma che diremo noi dell'apparente movimento dei pianeti tanto difforme, che non solamente ora vanno veloci e ora più tardi, ma talvolta del tutto si fermano, e anco dopo per molto spazio ritornano indietro? [121]

He then explains how these "esorbitanze" are simplified by the Copernican system.[122]

The angel then continues:

> What if seventh to these
> The planet earth, so steadfast though she seem,
> Insensibly three different motions move? [123]

Galileo's belief was that the Earth should be placed "in ischiera con le stelle," [124] and numbered "tra quelli che noi chiamo corpi celesti." [125]

The apparent fixity of the earth, the inhabitants of which have no sensation of movement, was to Simplicio a strong argument against its motion. He brings up a variety of proofs, such as that this motion would throw off all unattached objects, that a ball dropped from the summit of a tower would not fall at its base, and that we should continually perceive a rushing wind.[126] Salviati shows that none of these effects would be produced, but that the movement of the earth is, as Miltons' angel puts it, insensible:

> Qualqunque moto venga attribuito alla Terra, è necessario che a noi, come abitatori di quella e in conseguenza partecipi del medesimo, ei resti del tutto impercettibile, e come s'e'non fusse, mentre che noi riguardiamo solamente alle cose terrestri; ma è bene all'incontro altrettanto necessario che il medesimo movimento ci si rappresenti comunissimo di tutti gli altri corpi e oggetti visibili, che essendo separati della Terra mancano di quello.[127]

To this investigation much of the second day of the *Dialogue* is devoted. Salviati explains that the air and all things on the surface of the earth participate in its motion, which is no more disturbing than is the regular movement of a boat to the passengers in its cabin.[128] Only by observing the position of the earth with respect to the heavenly bodies can its motion be perceived. Milton's angel sums up Salviati's idea when he enquires whether the earth

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[121] *Dialogo*, p. 373.
[122] *Ibid.*, pp. 373 ff.
[123] *P. L.* 8. 148-50.
[124] *Dialogo*, p. 109.
[125] *Ibid.*, p. 126.
[126] *Ibid.*, pp. 139 ff.
[127] *Ibid.*, p. 127.

> from west her silent course advance
> With inoffensive pace that spinning sleeps
> On her soft axle, while she paces even,
> And bears thee soft with the smooth air along.[129]

A further argument by Simplicio is that even if the earth had motion, it could have but one:

> D'un mobile semplice, un solo e non più può essere il moto che gli convenga naturalmente, e gli altri tutti per accidente e per partecipazione, in quel modo che a colui, che passeggia per la nave, suo moto proprio è quello del passaggio, e per participazione quello che lo conduce in porto, dove egli mai col passeggio non sarebbe arrivato, se la nave col moto suo non ve l'avesse condotto. . . . Aristotile vi dice, che siccome d'un mobile uno è il moto, così di un moto uno è il mobile, e in conseguenza, che senza l'inerenza del suo suggetto, non può nè essere, nè anco immaginarsi alcun movimento.[130]

The accidental motions to which Simplicio refers are those which the heavenly bodies were supposed to derive from the *primum mobile*. But the earth, if it moved according to Galileo's belief, would have all its motions in independence. These motions, Simplicio supposed, were three; after referring again to Aristotle's dictum on simple bodies and simple motions, he continues:

> Qui alla Terra, corpo semplice, vengono assegnati 3 se non 4 movimenti e tra di loro molti differenti; poichè oltre al moto retto, come grave, verso il centro, che non se gli può negare, se gli attribuisce un moto circolare in un gran cerchio intorno al Sole in un anno e una vertigine in sè stessa in ventiquattr'ore. E quello poi che è più esorbitante, e che forse perciò voi lo tacevate, un'altra vertigine intorno al proprio centro, contraria alla prima delle ventiquattr'ore, e che si compie in un anno. A questo l'intelletto mio sente repugnanza grandissima.[131]

Salviati explains that the last motion is not real:

> Quanto poi al terzo moto attribuitole dal Copernico in sè stessa in un

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[128] *Ibid.*, p. 278. Cf. pp. 139 ff. Galileo was aware that the trade winds are caused by the rotation of the earth (p. 474).

[129] *P. L.* 8. 163-6.

[130] *Dialogo*, p. 135.

[131] *Ibid.*, p. 431.

anno, solamente per conservare il suo asse inclinato e diretto verso la medesima parte del Firmamento, vi dirò cosa degna di grandissima considerazione; cioè, che *tantum abest* che (benchè fatto al contrario dell'altro annuo) in esso sia repugnanza o difficultà alcuna, che egli naturalissimamente e senza veruna causa motrice compete a qualsivoglia corpo sospesa e librato; il quale, se sarà portato in giro per la circonferenza di un cerchio, immediate per sè stesso acquista una conversione circa 'l proprio centro contraria a quella che lo porta intorno, e tale in velocità, che amendue finiscono una conversione nell'istesso tempo precisamente. . . . Se poi andrete più accuratamente considerando, vi accorgerete quest'esser non cosa reale, ma una semplice apparenza; e quello che vi assembra essere un rivolgersi in sè stesso, essere un non si muovere e un conservarsi del tutto immutabile rispetto a tutto quello che fuor di voi e del vaso[132] resta immobile.[133]

Continuing his discourse to Adam, the angel says that if movement is not attributed to the earth, the motions of the planets

to several spheres thou must ascribe,
Moved contrary with thwart obliquities.[134]

These motions of the spheres were the first requirements of the Ptolemaic astronomy, and their complication was a source of trouble to all astronomers. Salviati says:

Il principale scopo dei puri astronomi è il render solamente ragione delle apparenze nei corpi celesti, e adesso ai movimenti delle Stelle adattar tali strutture e composizioni di cerchi, che i moti secondo quelle calcolatti rispondano alle medesime apparenze, poco curandosi de ammetter qualche esorbitanza, che in fatto per altri rispetti avesse del difficile. E l'istesso Copernicano scrive aver egli ne'primi suoi studi restaurata la scienze astronomica sopra le medesime suppositizione di Tolomeo, e in maniera ricoretti i movimenti dei pianeti, che molto aggiustatamente rispondevano i computi all'apparenze, e l'apparenze ai calcoli, tuttavia però che se prendeva separatamente pianeta per pianeta. Ma soggiugne che nel voler poi comporre insieme tutta la struttura delle fabbriche particolari ne risultava un mostro e un chimera composta di membra tra di loro sproporzionatissime e del tutto incompatibili; sì che, quantunque si soddisfacesse alla parte dell'astronomo puro calcolatore, non però ci era la soddisfazione e quiete dell'astronomo filosofo.[135]

On the contrary and oblique movements of the spheres, Salviati says:

In Tolomeo bisogna assegnare ai corpi celesti movimenti contrari, e far che tutti si muovano da levante a ponente, e insieme da ponente verso levante; che nel Copernico son tutte le revoluzioni celesti per un sol verso, da occidente in oriente. . . . E non chiamereste voi, signor Simplicio, grandissimo assurdo, se nella costruzion di Tolomeo, dove a ciascun pianeta sono assegnati propri orbi, l'uno superiore all'altro, bisognasse bene spesso dire che Marte costituito sopra la sfera del Sole calasse tanto, che rompendo l'orbe solare sotto a quello scendesse, e alla Terra più che il corpo solare si avvicinasse, e poco appresso sopra il medesimo smisuratamente si alzasse? E pur queste e altre esorbitanze dal solo e semplicissimo movimento annuo della Terra vengono medicate.[136]

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[132] Used by Salviate in an experiment to prove his principle.

[133] *Dialogo*, p. 431. Cf. p. 444. [134] *P. L.* 8. 431-2. [135] *Dialogo*, p. 372.

Under the old system the immediate motive force of the spheres was the *primum mobile,*

that swift
Noctural and diurnal rhomb supposed
Invisible else above all stars, the wheel
Of day and night.[137]

Simplicio has full faith in this as the cause of the diurnal movement of the heavens. His words suggest its imaginary and invisible character as a creation of astronomers:

Hanno ritrovata gli astronomi e i filosofi un'altra sfera altissima senza stelle, alla quale naturalmente compete la conversion diurna, e questa hanno chiamata il primo mobile, il quale poi rapisce seco tutte le sfere inferiori, contribuendo e participendo loro il movimento suo.[138]

Sagredo in his reply refers to it as "incognita," and, with a touch which suggests Milton's "save the sun his labor," calls the conditions of the *primum mobile* "strane e laboriose." But all of this, Raphael says,

needs not thy belief,
If earth industrious of herself fetch day
Travelling east, and with her part averse
From the sun's beams meet night, her other part
Still luminous by his ray.[139]

This is the idea of Sagredo when he says:

Fate che la Terra sia il primo mobile, cioè fatela rivolgere in sè stessa in ventiquattr'ore e per il medesimo verso che tutte le altre sfere, che senza participar tal moto a nessun altro pianeta o stelle, tutte avranno i lor orti, occasi, e in somma tutte l'altre apparenze.[140]

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[136] *Ibid.*, p. 373. Cf. pp. 131, 134-6, 296, 429.

[137] *P. L.* 8. 133-6.

[138] *Dialogo,* p. 136.

[139] *P. L.* 8. 136-40.

[140] *Dialogo,* p. 136.

Salviati is of the same opinion:

> Ed ecco con due semplicissimi movimenti fatti dentro a'tempi proporzionati alle grandezza loro e tra sè non contrarianti, anzi fatti, come tutti gli altri de' corpi mondani, mobili da occidente verso oriente, assegnati al globo terrestre, rese adequate ragioni di tutte quelle medesime apparenze, per le quali salvare con la stabilità della Terra è necessario (renunziando a quella simmetria che si vede tra le velocità e le grandezze dei mobili) attribuire ad una sfera vastissima sopra tutte le altre una celerità incomprensibile, mentre le altre minori sfere si muovano lentisimamente; e più far tal moto contrario al movimento di quelle, e, per accrescere l'improbabilità, far che da quella superiore sfera sieno contro alla propria inclinazione rapite tutte le inferiori.[141]

This great disparity between the elaborate machinery of the old system and the simple explanations of the new is Galileo's chief argument.

If the earth moves as a planet, she like them gives light to the other heavenly bodies:

> What if that light
> Sent from her through the wide transpicuous air,
> To the terrestrial moon be as a star
> Enlightening her by day, as she by night
> This earth?[142]

The possibility that the earth gave light to the moon was affirmed by Salviati:

> La reflessione della Terra possa illuminar la parte tenebroso della Luna con luce non minor di quella, con la quale la Luna illustra le tenebre della notte, anzi tanto più, quanto che la Terra è quaranta volte maggior della Luna.[143]

He adds further:

> Ma sarebber ben degni di riprensione, se mentre vogliono che noi concediamo e crediamo a loro, che la Luna operi in Terra col lune, e'volessin poi a noi, che gli aviamo insegnato che la Terra illumina la Luna, negare l'azione della Terra nella Luna.[144]

Simplicio is, naturally, unwilling to receive this, and replies:

> In somma io sentio in me un'estrema repugnanza nel potere ammettere questa società, che voi vorreste persuadermi tra la Terra e la Luna,

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[141] *Ibid.*, p. 429. Cf. pp. 152, 284, 296, 297, 398.

[142] *P. L.* 8. 140-4. Cf. *P. L.* 8. 157, and pp. 169 and 175, *supra.*

[143] *Dialogo,* p. 102. Cf. pp. 73-113.

[144] *Ibid.*, p. 109.

ponendola, come si dice, in ischiera con le stelle; chè quando altro non ci fusse, la gran separazione e lontananza tra essa e i corpi celesti, me par che necessariamente concluda una grandissima dissimilitudine tra loro.[145]

To admit that the earth like the moon gave light carried with it the belief that the surface of the moon was like that of the earth, and not, as Simplicio believed, "pulitissima e tersa." [146] Salviati, as we have seen,[147] explains that its surface is varied and mountainous. Galileo was, however, unwilling to affirm the possibility of inhabitants on the moon. Simplicio characterizes such a thought as "o favoloso o empio." Sagredo thinks that the moon, though habitable, may be occupied by beings beyond man's power to imagine:

Ma non intendo già come, tuttavoltachè non vi si generino cose simili alle nostra, si deva di necessità concludere, che niuna alterazione vi si faccia, nè vi possano essere altre cose, che si mutino, si generino e si dissolvano, non solamente diverse dalle nostre, ma lontanissime dalla nostra immaginazione, e in somma del tutto a noi inescogitabili.[148]

Salviati is also unwilling to affirm anything.[149]

Continuing the dialogue, Milton's angel suggests other solar systems:

Other suns perhaps
With their attendant moons thou wilt decry.[150]

Here the "moons" are apparently the planets, which shine only with reflected light, as Salviati explains,[151] and the "suns" are the fixed stars, to which he refers as "tanti Soli." [152]

Raphael again states the main issue and advises Adam on it:

Whether the sun predominant in heaven
Rise on the earth, or earth rise on the sun,
He from the east his flaming road begin,
Or she from west her silent course advance, . . .
Solicit not thy thoughts with matters hid,
Leave them to God above, him serve and fear;
Of other creatures, as him pleases best,
Wherever placed, let him dispose: joy thou
In what he gives to thee, this paradise

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[145] *Ibid.*, p. 109.

[146] *Ibid.*, p. 78.

[147] P. 159, *supra.*

[148] *Dialogo*, p. 70.

[149] *Ibid.*, p. 71, quoted on p. 174, *supra.*

[150] *P. L.* 8. 148-9.

[151] *Dialogo*, p. 291.

[152] *Ibid.*, p. 356.

> And thy fair Eve: heaven is for thee too high
> To know what passes there; be lowly wise:
> Dream not of other worlds, what creatures there
> Live, in what state, condition or degree,
> Contented that thus far hath been revealed
> Not of earth only but of highest heaven.[153]

Galileo was aware of the inadequacy of man's mind to grasp at once the full truth of nature, and felt that many things were "hid" from the wisest.[154] Nevertheless, man can gain profit from the study of nature, according to what Salviati calls the "dottrina divina"

> la quale mentre ci concede il disputare intorno alla constituzione del Mondo, ci soggiugne (forse acciò che l'esercizio delle menti umane non si tronchi o anneghittisca) che non siamo per ritrovare l'opera fabbricata dalle sue mani. Vaglia dunque l'esercizio permessoci e ordinatoci da Dio per riconoscere e tanto maggiormente ammirare la grandezza sua, quanto meno ci troviamo idonei a penetrare i profondi abissi della sua infinita sapienza.[155]

This is Milton's

> the more
> To magnify his works, the more we know.[156]

He also expresses it by putting in the angel's mouth:

> To ask or search I blame thee not, for heaven
> Is as the book of God before thee set,
> Wherein to read his wondrous works, and learn
> His seasons, hours, or days, or months, or years.[157]

The man of science speaks of the "gran libro della Natura,"[158] from which could be learned "le maraviglie di Dio nel Cielo."[159] The poet and the scientist are at one in their conviction that man's knowledge of nature is limited and inadequate, and that nevertheless the study of created things offers an avenue toward the world of spiritual truth.

The question is asked: With which astronomer did Milton agree, Galileo or Ptolemy? But this is not the matter of greatest importance. Milton understood Galileo and applauded his studies, while at the same time using without hesitation the ideas of the older astronomy. And it would have been folly in Milton to have decided with certainty either for or against the Copernican view. Indeed, Huxley is credited with the remark that in his opinion the Ptolemaics of Galileo's time had rather the better of the argument. Until the publication of Newton's *Principia* in 1687, the Copernican system did not have an assured basis. To expect Milton to pass beyond interest in Galileo and consideration of his views as possible and probable, and definitely declare for Copernicus, is to ask him to do what only a professional astronomer had a right to do.

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[153] *P. L.* 8. 167-78.

[154] *Dialogo*, p. 492. Quoted on p. 171, *supra.*

[155] *Ibid.*, p. 502. Cf. pp. 114, 117, 292, 399, 402.

[156] *P. L.* 7. 96-7.

[157] *Ibid.*, 8. 66-9.

[158] *Dialogo*, p. 9.

[159] *Ibid.*, p. 12. Cf. pp. 71, 114.

Had Milton been an astronomer, he would doubtless have been a Copernican. But as a poet he spoke in terms understood by his readers. The average educated man of his day was familiar with and accepted Ptolemy, and could best be addressed in Ptolemaic language. Above all, Milton as a poet did not feel it his first business to be a teacher of astronomy, and to discuss controverted questions for the sake of enlightening his readers on recent advances in astronomical science. So far as the poet is a teacher of astronomy, he subordinates the subject to the higher purposes of poetry, sometimes that the truth may appear more "eloquently dressed," sometimes that the science may assist in showing forth the "throne and equipage of God's almightiness."

Milton was not a partisan of either system, and did not care which finally proved true. What he demanded was that students of science set themselves to their enquiries with diligence, and speak like his truth-loving author in the *Areopagitica:*

> When a man writes to the world, he summons up all his reason and deliberation to assist him; he searches, meditates, is industrious, and likely consults and confers with his judicious friends; after all which done, he takes himself to be informed in what he writes, as well as any that writ before him.

And the scientist must be left free to set forth the result of his enquiries. Scientific truth is not final, but always subject to improvement. Hence Milton felt no certainty that the Ptolemaic system could stand indefinitely. Yet, on the other hand, imperfect understanding of nature which had been secured by proper effort was of value, and need not be rejected as worthless. Though scholars should be unflagging in their search for the truth, the ordinary man need not feel dissatisfied with the state of knowledge in his day. A scientific conclusion even when on the point of supersedure might serve high ends, that is, it might aid man to "attain the knowledge of God and things invisible" through "orderly conning over the visible and inferior creature." Even though the Ptolemaic system were inferior to the Copernican, it was the result of long and patient study, and hence contained a portion of truth which could serve some of the best purposes of the scientific explanation of nature.

Milton held that neither of the two rival systems was so certainly superior to the other as to justify man in interrupting the "sweet of life" by anxiety about the proper choice. This is the meaning of the angel's exhortation:

> Solicit not thy thoughts with matters hid,
> Leave them to God above.

The theme of the folly of mental striving to the neglect of the fundamentals of morality and happiness is one of high import to Milton. At the end of his experience Adam comes to the conclusion:

> Henceforth I learn, that to obey is best,
> And love with fear the only God, to walk
> As in his presence, ever to observe
> His providence, and on him sole depend,
> Merciful over all his works, with good
> Still overcoming evil, and by small
> Accomplishing great things, by things deemed weak
> Subverting worldly strong, and worldly wise
> By simply meek, that suffering for truth's sake
> Is fortitude to highest victory,
> And to the faithful death the gate of life.

To this the angel replies:

> This having learnt, thou hast attained the sum
> Of wisdom; hope no higher, though all the stars
> Thou knew'st by name, and all th'ethereal powers,
> All secrets of the deep, all nature's works,
> Or works of God in heaven, air, earth, or sea.[160]

The wisdom that guides daily life aright is the highest; other learning is its handmaid. Only at man's peril can the knowledge of the material world be set above the practise of the good life.

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[160] *P. L.* 12. 561-71. Cf. 8. 191-7.